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# RHETORICAL ANALYSIS OF SCIENCE POLICY LITERATURE, 1960-1990

1) Basic Research Goals: A Comparison of Political Ideologies
2) Basic Research Goals: Perceptions of Key Political Figures

Prepared under contract to the Office of Technology Assessment
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# Basic Research Goals: A Comparison of Political Ideologies

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# BASIC RESEARCH GOALS: A COMPARISON OF POLITICAL IDEOLOGIES

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The period from the 1960s to the nineties saw considerable change in the basic research system of the United States, including funding goals and programmatic priorities as well as in actual spending for research. As part of its continuing effort to assist Congress in assessing the adequacy of the basic research system, OTA commissioned two rhetorical analyses of changes in expressed goals and programmatic priorities over the thirty year period. One research team (headed by Pollock) charted the official pronouncements of key political figures, such as the Presidents and the Directors of the National Science Foundation. A second team, whose report this is, considered the influence of ideology on arguments for funding basic science research. Samplings of opinion were taken from a wide variety of sources: Congressional Hearings, editorials and columns in science news publications, newspaper reports, speeches, Democratic and Republican Party Platforms, and Presidential pronouncements.

As used here, the term "ideology" designates a widely shared, loosely integrated system of beliefs. The charge to the investigators was to focus initially on three ideological pairs--Republican/Democrat, conservative/liberal and hawk/dove--while also examining the archival record for other possible ideological divisions on matters of spending for basic research. Thus, for example, we attended to the influence of the environmentalist

movement, as well as of persons and groups increasingly inclined to shift research monies from the government and the universities to the private sector. It was recognized from the outset that the labels conservative and liberal, hawk and dove were somewhat ambiguous; furthermore, that references to Democrats and Republicans as ideological groupings might well obscure important differences within each party. One of the purposes of this study was to explore the utility of these traditional understandings of political thinking with respect to arguments over funding for basic science research.

Note that the persons and groups we here discuss are not marginal. They are not the yippies of the sixties, the anti-technologists of the early seventies, or the pro-life activists of the eighties. Almost all are actors within or close to the mainstream of American political thought. Thus, for example, readers will find little documentation here of the rather extensive countercultural movement to overturn the "technoculture" except to the extent that the repercussions of that movement have filtered into more centrist thinking. In excluding the more extreme positions on the left and the right, we do not mean to imply-that such ideas have not been influential. Indeed, their influence has often been quite profound, either as a source of direct pressure on the mainstream or as a seedbed for innovation. Only when such ideas actually entered into a full public forum bearing directly on funding choices, however, were they considered in this study.

We shall argue that there has existed over the thirty year

span covered in this study a broadly shared ideology, covering goals, values, programmatic priorites and rationales. We call this broad ideology the "stable value consensus." Differences among the six major ideological groupings are discernible as well, but usually within a consensual framework, broadly defined. And these, more often than not, are differences in emphasis rather than in kind. Occasionally, too, new research goals and programmatic priorities are added to the consensual mix while others, previously emphasized, lose support. These emergences, convergences and divergences are the basic stuff of this research project. How they were expressed, to what audiences and via what media of expression, were also of interest.

## Method

This is a qualitative study offering conclusions about the nature and trajectory of arguments over time. In keeping with the goals of the research project, covering a broad range of opinions over an extended review period, the investigation focused on general goals and values as well as on a limited number of programs and project areas.

### Data Collection

Three criteria guided the initial search for materials. Surveyed first were references to spending for basic research in discourses by or about Democrats and Republicans, liberals and conservatives, doves and hawks. The positions of Democrats and Republicans were gleaned for the most part from their quadrennial Party Platforms and from statements by Members of Congress. Identifying individuals as liberals or conservatives, doves or hawks proved more difficult. Members of Congress could be

classified on the basis of Americans for Democratic Action and American Conservative Union ratings scales when those were available. When they were not, assessments were based on a source's self-identification, our prior knowledge, on news reports and on the advice of OTA staff, in that order. These categories were not always relevant to particular programmatic areas. For example, the dove/hawk distinction is of little value in parsing arguments over support for various versions of the "War on Cancer" in the early 1970s.

Second, anticipating the inadequacy of the a priori ideological categories, we developed a mechanism for including "new" ideological positions as they emerged from the texts under study. Members of the major parties do not clone one another's arguments, and their differences are not always explicable in liberal/conservative or hawk/dove terms. When a major argument did not fit comfortably with the bipolar pairs, we created a provisional category until it either made sense with respect to some larger position or firmed up as a genuinely unique point of view. To put the point another way: the three bipolar pairs allocate arguments under the individuals who make them. The process described here considers, first, the argument itself without respect to authorship.

Third, to ensure coverage of a broad range of issues, we focused upon several broad science projects and project areas, selected with the guidance of OTA staff. These included the Apollo program, the space shuttle, the War on Cancer, the Strategic Defense Initiative, genetic research, agricultural

research, and research into alternative sources of energy.

These categories were searched in several document and news indices, sampled once every three years as a matter of course and including as well Presidential election years and years in which significant programs were initiated. Indices searched for the full period include the Public Affairs Information Service Index, the CIS Index, the New York Times Index, The Weekly Compilation of Presidential Documents, and the Education Index. In addition to these nationally published indices, we searched manually through Vital Speeches of the Day and electronically through holdings of the New York University, City University of New York and the New School for Social Research libraries.[1]

The resulting data base consisted of roughly 2,000 pages of archival materials, selected by the investigators and by OTA staff from an initial pool of some 15-20,000 pages.[2] The initial pool was winnowed with a view toward selecting arguments that seemed 1) representative of the ideological mainstreams, and 2) illustrative of the leading conflicts and convergences during the period. We also selected materials that seemed especially clear and cogent. The search focused on documents that contained an explicit rationale for spending or not spending in a given area. Of related interest were statements that drew implications for spending from their praise or criticism of a particular project. Excluded entirely were assessments of a purely technical nature.

Data Analysis

Ideally, this study would have reconstructed rigorously the contextual meanings of ideological expressions. It would have

taken into account audience, occasion, and the capacity of language to mask agendas, saying things--often very telling--that a speaker would not seem likely to intend, and honoring in general the artistic dimension of human expression. It would have done so, moreover, with full documentation of its argumentative claims.

However, this kind of rhetorical analysis was not feasible within the time available for this study. Perforce, the investigators were required to render seat-of-the-pants judgments about many things, attempting where possible to remain sensitive to the nuances of language, incorporate an understanding of the substantive issues, account for the differences among speakers and their agendas, and in all cases, focus on the text as the principal element of the analysis.

The method of this study, then, was qualitative rather than quantitative content analysis. Qualitative content analysis moves beyond quantitative content analysis to an assessment of the commitments and implications embodied in a given text. The quantitative content analyst might be able to say, for example, that Congressman X argued vigorously in favor of space shuttle funding in a speech of 1562 words that made 7 references to spinoff technologies and 3 to defense needs. The qualitative content analyst is more concerned with how such references are expressed, drawing parallels between Congressman X's speech and others on similar occasions in order to determine the relative shadings and valuings of an idea. It is necessarily a more subjective process than pure content analysis, but it is not

arbitrary.[3]

It should be emphasized that the task of comparing thousands of pages of statements by scores of individuals and groups, appearing in diverse genres and media of communication over a thirty year period, was a daunting one. So too were the problems of tracking shifting and ambiguous terms, such as "basic" versus "applied" research, as they were used by dozens of sources in as many contexts. The study was also more macroscopic than microscopic in its scanning of archival materials. Of necessity, it glossed over differences that another, more comprehensive study might have attended to:

1. In comparing dozens of speakers from diverse institutional positions who operate on different assumptions about the issues at stake, the analyst is at risk comparing claims that seem similar but are actually quite different, or of ignoring claims that seem disconnected but are actually directly responsive. In addition, shades of meaning that are quite important in one context often do not translate into another. We dealt with the diversity of sources in two ways. First, we did not try to represent the ideas of individual speakers in our analysis. Where individuals are quoted, their language is used as an example, not as a text privileged above others. Such an approach sacrifices detail in favor of comparability. Second, remarks from commentators who remained in the mainstream more often focused on some identifiable program or process rather than different ideal goals only tangentially related to that process or program.

In general, we chose to compare ideologies where they most closely intersected rather than extrapolating from dissimilar cases.

2. The study covers several different types of texts, including guest editorials, Congressional testimony, newspaper quotations, journal articles and book-length manuscripts. Each has its own norms of expression; what would serve in one venue might be decidedly inappropriate for another. We tried, insofar as possible, to account for these differences in making our comparisons. For example, stridency and overstatement are more common to the campaign stump than to the writing in technical journals. A cautious endorsement of a program in Technology Review would therefore not automatically be thought less vigorous than a much louder endorsement on the campaign trail if the arguments were structurally similar. We emphasize that this "correction" is imperfect, involving a great deal of subjective discretion on the part of the analyst.

3. The social and political contexts of the funding arguments shifted markedly from 1960 to 1990. Further complicating the issue is the fact that the very arguments under study may not have only responded to but caused some of these shifts. This feature of the database served as an aid almost as much as it did a hindrance. The rise of the environmental movement, for example, prompted research in some areas and established broad positions that had the effect of coordinating individual arguments, both for and

against various programs. Still, the exact relationship between the various arguments and the emergent context could not always be accounted for in a systematic way.

We would emphasize that these results should be read as exploratory rather than final. There is a great deal more detail to be uncovered and a vast variety within the individual texts that cannot be treated here.

## General Goals, Values, and Programmatic Priorities

### The Stable Consensus

The consistency of argument over the period studied is remarkable. Advocates who disagree hotly with one another are likely to confine their dispute to the efficiency with which a given program pursues a goal, rather than questioning the desirability of the goal itself. The same arguments about health, economic competitiveness, national image and the like are constants in arguments about science funding policy from all ideological perspectives. We call this set of perennial concerns the stable value consensus. The consensus is important; it may account in no small measure for the ability of the basic research system in the United States to persist without major disruption along predictable lines, and it may provide a framework within which expressions of differences in opinion become intelligible and open for assessment.

The stable consensus includes the following goals and values:

Goals/terminal values: Economic well being, health and welfare, enhanced quality of life, increased knowledge and/or understanding, advancement of national interests.

The primary interest of policymakers appears to be in national benefits, with varying degrees of concern for benefits to mankind more generally or to subsections of the domestic population. National interests include security, prestige and economic/technological competitiveness.

Instrumental values: Cost effectiveness, efficiency, creativity, objectivity, technical excellence, competence of agents and/or agencies, advancement of the scientific professions, science education.

Programmatic Priorities: Stable priority areas--those strongly valued across the thirty year time period--include defense R & D, exploration of space, agricultural improvement, and biomedical research.

While the foregoing list may appear banal to the point of not meriting attention, several interesting observations can be made about it. First, the list excludes some values, such as economic/political equality, which were front and center on the American agenda for the last thirty years in other policy contexts. Second, it excludes values such as ideological conformity that have played a major, albeit constraining, role in other societies. Third, it is difficult to arrange the lists in any order that holds throughout the entire thirty years. Rather than being seen as mutually exclusive or as preferentially ordered, the values listed as terminal are often seen as cross-cutting or complementary, and they are sometimes offered as justifications, one for another. For example, improved health may be said to depend on better science education and to

contribute to America's economic advancement and national security. As they are used to justify each other, each of these goals is at the same time reinforced as a positive value.

Shifts in Goals, Values and Programmatic Priorities

Emphases given to specific programs (e.g., the War on Cancer, Apollo) have varied over the years and are the subject of our programmatic reviews (see below). Areas earning new or greatly increased attention during this period include energy and environmental protection. Throughout the thirty year period there has been implicit, if not explicit, acknowledgment of the need for an appropriate mix of "pure" versus "applied" research, of civilian versus military spending for research, and of governmentally sponsored versus privately administered research. Just what these mixes should be has been a matter of considerable controversy. However, we note, for example, that proponents of both basic and applied research each tend to argue on the ground of the other: the "purist" claiming the practicality of the pure; the "applied" advocate recalling the remarkable advances in basic knowledge made as an inadvertent consequence of applied research.

The following timelines outline the major shifts in thinking about funding for basic science research from 1960-90. In each case we will present a narrative of major events and then move to a discussion of the central characteristics as we understand them. Our discussion will point up the limitations in the way the data have been parsed as well as the strengths.

Timeline One: Emergences, Convergences and Divergences in Values Over Time

1960-68--Research was perceived as a means of increasing national prestige, enhancing security, and providing benefits. The collective goals of outdistancing the Soviets and maintaining a leadership position in the world outweighed the more tangible benefits that might devolve upon subsections of the population. This nationalistic image of scientific research was supported by Democrats and Republicans, liberals and conservatives, hawks and doves. The more extreme factions of these last four categories were, however, less likely to endorse research as the most efficient means to pursue these goals. Doves were convinced that research monies for defense could better be spent on domestic problems.[4] Hawks believed that direct expenditures on defense R & D would be more effective.[5] Republicans sought to distance themselves from Democrats in the 1960 Party Platform by promising a science more directed to the solution of problems than the "moral" task of the Democrats, but they too subordinated this element of science agenda to national image.[6]

1969-72--Science during this period was burdened with greater material expectations. Preservation of national preeminence remained as a strong goal on all fronts, but different groups stressed different tangible rewards. The Democratic Party Platform in

1972 argued that research should protect the environment and improve employment for scientists.[7] In the same year, the Republicans sought a science that would improve our economic competitiveness internationally.[8] Liberals and conservatives clashed over the pace and extent of environmental initiatives. These differences were expressed--particularly by those not identified with the environmental movement--as disagreements over specific programming rather than the importance of a clean environment.

1973-80--Democratic and Republican priorities diverged markedly during this period, even while agreeing on some specific program areas. For example, both Democrats and Republicans supported energy research in their 1976 party platforms. The Democrats made a straight-forward case for government investment, calling for "Major federal initiatives, including major governmental participation in early high-risk development projects . . . ." The 1976 Republican Party Platform began to detail the importance of maintaining a balance between private, university and government efforts at scientific research. They pledged to "support a national science policy that will foster the public-private partnership to insure that we maintain our leadership role."[9] Leadership and competitiveness were portrayed alike as the result of a proper system for conducting science. The position in the platform was deepened considerably in the Office of

Management and Budget's "Issues '78," which accompanied President Ford's final budget.[10] "Issues" stressed the importance of leaving a role for the private sector and avoiding government involvement in bringing technologies into readiness for commercial development.

The 1976 Democratic Party Platform made no reference to science beyond specific programs, but President Carter and Frank Press developed a novel set of concerns for science overall. The Carter administration was much friendlier to demonstration projects, reasoning that benefits could be realized "only at the development stage."[11] The federal role was to "accelerate" such development.[12] The Democrats also internationalized the understanding of science benefits, arguing that the export of research could accomplish foreign policy goals and ameliorate the influence of hostile ideologies.[13] Though the goals were similar in some respects to the "preeminence" arguments of the 1960s, the technique was much different. In the Carter/Press model, foreign nations were supposed to be impressed by the benefits they received, not the unalloyed might of the United States. This perspective was articulated most vigorously late in the Carter administration.

1981-88--The Republican agenda in the 1980s took the "Issues" agenda yet a step further, arguing that "partnerships" between government, universities and

industry were the best way to promote research, leaving virtually all development issues to industry except in cases of a pressing defense interest. President Reagan's Science Adviser, George A. Keyworth, II, articulated his vision of a science policy that would not "interfere" in processes best left to private enterprise, but would nevertheless take the prospect of technology transfers into account when making funding decisions. He was thus able to justify reducing, and in many cases, eliminating allocations for demonstration projects while arguing that basic science should be tilted toward the possibility of industrial applications. He said before the Subcommittee on Science and Technology on February 3, 1983, that "R & D is the essential source of knowledge for new industries--and eventually, new jobs. As a nation we're committed to growth through new technology; that is our future. So we're confronted with the challenge of using federal R & D programs to achieve maximum impact on our destiny. For that reason you'll find that a number of our proposed FY 1984 initiatives are designed to facilitate the interaction between fundamental research and its eventual applications in industry."[14] This explicit rationale was hotly contested by Democrats such as George Brown, who argued that the administration's emphasis on applications, coupled with a massive increase in the research funds oriented toward defense, tarnished relations between

the President and the scientific community. Dove and liberal commentators attacked the Reagan administration for failure to address a research agenda beyond defense and the pocketbook.

1988-90--The rising prominence of new megaprojects--the human genome, the superconducting super collider, the aerospace plane--generated a great deal of concern about smaller science, which continues to this day. Frank Press claimed in 1988 that the scientific establishment would have to acknowledge the impossibility of serving all research constituencies given the "robust" character of modern science.[15] He argued that the first priority should be protection of the research infrastructure, particularly its capacity to service projects both small and large. He also argued that all big science projects could not be pursued simultaneously, a position that dovetails with D. Allan Bromley's early statements on the subject.[16] The 1988 Republican Party Platform emphasized research that would improve competitiveness and remove restraints on enterprise.[17]

The first timeline has the virtue of calling attention to only the most significant issues and illustrating major group support for each initiative and/or set of ideas. It also suffers from the problems of truncation, most notably, a failure to show a) exactly how the ideas progressed, b) how the shape of the value consensus changes over time, and c) disagreements within

the major ideological constituencies.

Recognizing these limitations, the timeline does point up several interesting changes. First, the issues of moment after 1975 are as likely to involve the conduct of science as the anticipated results of the science. Limiting the federal role, as the GOP sought to do in 1977 (and again much more energetically during the Reagan Administration), assessing the resource crowding fostered by megaprojects, and calling for market-oriented funding criteria are concerns of a general nature, bearing on a wide variety of programs, that were not much in evidence before 1975. To use the language from above, the value orientations included much more instrumental language.

Second, even divergences from the general consensus point up the power of the central arguments. Economic competitiveness has long been mentioned as a reason for doing research, and particularly, for pushing research toward the marketplace. That has been true of liberal, Democratic projects such as solar power research; true of conservative, Republican projects, such as the Commercially Developed Space Facility; and true of dovish projects such as improved low-investment agricultural technologies (by their nature, hawkish programs are not generally intended for the market). The question is not so much whether an argument is inherently liberal or conservative, Democratic or Republican, but when it is invoked, how, and by whom.

Third, partisan clustering around initiatives seems more characteristic of the period from 1976-90 than of the period from 1960-75. This clustering is complicated, however, because advocates have become sophisticated in arguing not against

goals--very few questions about basic orientations come to bear on funding controversies--but against the ways in which goals are or are not being carried out. This poses problems for an analysis focused tightly on rhetoric to the exclusion of other considerations. A dramatic example of the difficulties emerged during a hearing before the Subcommittee on Natural Resources, Agriculture Research and the Environment on October 22, 1981. EPA Administrator Anne Gorsuch was attempting to justify a request for reducing the agency's allocation for epidemiological research in the face of skepticism from the Members of the Subcommittee. The following is a selection from her exchange with George E. Brown, Jr., and Albert Gore, Jr.:

> Mr. Brown. My criticism and the criticism of this committee was not to the fact that we don't need epidemiology, but that we need good epidemiology and we trust you will get good epidemiology in some fashion even though you are apparently proposing to eliminate a lot of the long-term epidemiological research. Would you care to comment on that?
>
> Mrs. Gorsuch. . . . I concur wholeheartedly that we do need to continue to use more and better epidemiology but to recreate that equality (sic) program in EPA as opposed to the other Federal agencies where that type of work is done does not seem to us to be a wise expenditure of money. . . . There is nothing disingenuous about this.
>
> Mr. Gore. It is the height of disingenuity for you to tell the chairman that you believe EPA should perform this

function, this very narrow function of long-term effects related to energy. . . . Now how do you reconcile your statement to the chairman that you think that specific function is a necessary and valuable one for you to perform, with your request to OMB for zero dollars and zero cents to perform that function?[18]

Here the advocates split along plain partisan lines--two liberal Democrats against a conservative Republican--but do not express disagreements over their goals. The question is, rather, does Mrs. Gorsuch's position actually serve the goal? If one were to assume the basic thrust of then Representative Gore's argument, this passage testifies to the power of the stable consensus even as it is honored in the breach.

Timeline Two: Relative Intensity of Support/Opposition for Programs and Programmatic Areas, by Program, Area and Ideology

Timeline 2 is a summary representation of a group's position on a programmatic area. The following narrative timelines provide chronological context. The three programmatic areas--cancer, space and strategic defense research--were chosen to provide detailed illustrations of issues typical of science funding in other areas as well.

Cancer

1971--President Nixon announced a "moonshot" model for cancer research, promising a "war" against the disease.[19] The goals were endorsed with near unanimity, but controversy arose over program administration. Some questioned the prospects for short term success; others were concerned about what

seemed an inflated role for the National Cancer Institute. There was no significant difference of opinion that was consistent across ideological groups. This initiative was a strong indication of the continuing appeal of the large project model following in the wake of the moon landing.

1972-79--Legislators and other observers became increasingly frustrated with the lack of progress toward a "cure." Some researchers argued that small-scale, privately funded efforts have more chance for success than broad-based, centralized federal projects.[20] These researchers claimed that there are "many cancers," which make impossible the very idea of a single-project approach. This controversy paralleled thinking in the broader research community on the importance of maintaining strong financial support from government without overcentralizing research.

1980-88--Frustration with the "failures" of cancer research, problems David Baltimore likened to "another Vietnam," led to widespread (though certainly not unanimous) hostility to a) the notion that dollar-driven science can achieve dedicated goals, and b) the concept of centralized medical science.[21] This was an influential element in the early reluctance to mount a "moonshot" effort to deal with AIDS. Private clinics offered services along lines justified ten years earlier, featuring a "heterogeneous" approach to cancer. At the same time, many observers, such as Baltimore and Lewis



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Thomas, though opposed to the "overselling" of the original cancer program, remain convinced that advances such as the detection of the oncogene owe a good deal to the sustained, coordinated effort of the National Institutes of Health.[22]

Space: Focus on Apollo, Shuttle

1961-69--John F. Kennedy's goal of sending a man to the moon was framed in terms of demonstrating and developing U.S. technology. Initial enthusiasm had, by 1964, generated a sizeable group of skeptics as well. The project was opposed by liberals such as J. William Fulbright, who argued that the Apollo project distorted priorities, and conservatives such as Barry Goldwater, who argued that crash programs are costly, dangerous and divert attention from defense.[23] The benefits of Apollo, like other science programs that could not easily demonstrate benefits to either "guns" or "butter" advocates, were presented with such objections in mind. Proponents of the space program began to argue benefits in addition to the "moral" advantages of being "first in space," including enhanced communications, improvements in security and the prospect for the commercial development of space.

1969-72--The initial euphoria of the lunar landing gave way to disappointment over slim short term tangible benefits. The most immediate result was considerable Democratic opposition to the proposed shuttle program

combined with Republican demands that the program pay direct benefits to the nation.[24] The shuttle dispute presented at least two arguments that were to resurface in future debates over the funding of science: "technology lock" and concern that the military would consume too much of the research pie. Some Democrats feared that early commitment to the shuttle would lock the nation into one kind of technology where another might turn out to be more appropriate after additional research. Similar concerns would later appear in arguments over alternate energy resources, SDI weapons systems and other science projects. Liberals and doves wanted to restrict the military applications of the shuttle in order to keep the benefits squarely in the civilian realm. The Democratic opposition was far from unanimous, however. Many argued, along with the Republicans, that the shuttle offered the most promising means of achieving short term benefits from the space program, as well as a means of sustaining NASA's role in space exploration.

1973-85--The debate over the utility of the shuttle centered on the choice between manned and unmanned space flight. Liberals such as Carl Sagan argued that unmanned vehicles could do as much as--and often more--than could manned flight.[25] Proponents of the shuttle, including other liberal advocates such as Frank Press, argued that the shuttle offered greater flexibility and long term savings.[26] As the shuttle's position firmed

up, arguments hinged on the major thrust of the program. Technological spinoffs were important to most advocates, regardless of ideological orientation. Conservatives were more likely to value the defense component of the shuttle's mission alongside the potential economic benefits. Liberals were more likely to argue that the military payloads crowded out more appropriate, more beneficial (in terms of spinoffs) civilian projects. Some liberals discounted the value of the shuttle and related projects altogether, claiming that we should focus on the less expensive unmanned projects and spend the remainder on more directly earth-bound concerns.

1986-89--The Challenger disaster did not do in the shuttle program, but did reopen the discussion to cover other sorts of space missions. Of particular interest during this period was the push for privatization of space, specifically, the debate over the licensing of a commercially developed space facility (CDSF).[27] Conservatives who had supported a large military role for the space program found the CDSF threatening to that aspect of NASA's efforts. Liberals worried about the cooptation of public benefits by private industry. Conservatives and liberals alike were concerned that the CDSF could threaten NASA's existence. The largely conservative support for the CDSF used the old liberal argument for unmanned vehicles (the CDSF in question

would have been an unmanned facility), stressing their lower cost and superior capabilities vis a vis the relevant research goals. Principals in the space science community argued simultaneously, in terms highly reminiscent of the Kennedy period in manned space flight, that a space station would secure NASA's future, build national pride, stave off Soviet pretensions to a premier role in space and demonstrate the superiority of U.S. technology.

SDI

1983-85--President Reagan's 1983 challenge to develop space-based strategic defenses came as a surprise to the scientific community. Surprise turned to excitement in some sectors and consternation in others as vast sums of federal dollars were made available for research projects related to SDI interests. Some scientists embraced the program as a windfall; others argued that it placed institutions--universities in particular--in an untenable political position.[28] Without explicitly supporting or opposing SDI's orientation, others worried about the extent to which the large amount of money available for the related projects would distort the conduct of science in other areas by drawing talented researchers away from less well funded projects.

1986-90--Coherent opposition to SDI, ostensibly based on the scientific merits of the proposal as well as political feeling, involved a great many scientists nationwide.

Liberals argued that SDI's great cost was unsustainable in itself and crippled more deserving programs. Liberals and many Democrats argued further that SDI was bad military policy as well as bad science. Conservatives outside of the original key supporters grew less vocal and deployment was postponed (if not shelved) after George Bush assumed the Presidency.

Programs that might appear on the surface to be rather similar evidence different patterns of partisan support. The Apollo mission was the focal point of space science and manned flight in the sixties; the shuttle took over that role in the 1980s (and developmentally in the 1970s). The loci of support and hostility shifted around concerns other than this central characteristic. Democratic and Republican support for Apollo and the shuttle changed places with one another--the Democratic profile for the shuttle looks very much like the Republican for Apollo and vice versa--but otherwise remained much the same. Liberal and conservative support shifted in kind, however, responding in part to changes in the nature of competition with the Soviet Union, in part to changing definitions of liberalism. Furthermore, one can see changes with respect to the economic arguments made on behalf of the shuttle to a much greater extent than was ever the case with Apollo.

More interesting still is the comparative placement of hawk and dove sentiment on the two programs. Apollo was not a "dove" project per se, but it did not promise the same sort of military missions as did the shuttle. Arguments that robots could do a

better job became much more compelling when there was a reason to oppose the favored system that went beyond greater desire for another.

Timeline Three: Changing Perspectives on Leadership/Competition Over Time

Timeline 3 charts the trajectories of three variants of the "America first" arguments offered in behalf of basic research: head-to-head competition with the Soviet Union, less specific insistence that the United States maintain its lead over other nations, and general economic competitiveness.

1960-69--Competition with the Soviet Union dominated early arguments for the weapons research, the space program and several other early sixties science projects. Liberals as well as conservatives, Democrats as well as Republicans argued vigorously for besting the Soviets. Shortly into the sixties, however, another, less directed form of competition became important. Advocates of all stripes would argue for the U.S. position against all other sources, specifying the Soviets more frequently than any other named adversary, but increasingly, not naming any adversary at all. Democrats, liberals and doves grew more prone to argue in these less directed terms as the decade wore on while Republicans, conservatives and hawks clung more tightly to the anti-Soviet posture.

1970-90--Economic competitiveness had become a strong claim on research by the time it was incorporated into the Republican Party Platform in 1972. It was to become

> much more so throughout the next eighteen years, particularly with the election of Ronald Reagan. George Keyworth institutionalized a set of science funding criteria that stressed the eventual marketability of a proposed project. He also posited a relationship between business and government that put government in a facilitative role vis a vis saleable R & D. During this period the interest in preserving U.S. preeminence and the concern for the Soviets did not dwindle, but it was increasingly expressed in economic terms and much more often took account of other adversaries. Japan and Europe emerged frequently as the challengers against whom the U.S. would have to preserve its scientific, technological and financial place. Military rationales still favored overwhelmingly the Soviet Union as the opponent.

By breaking out a rationale, rather than a project area or an ideology, Timeline 3 affords a look at how ideas change through time. Many commentators have celebrated the "demise" of militarism in the early months of 1990. Without endorsing their optimism, it is interesting to note that militarist and bipolar rationales were on the wane as a locus of science funding argumentation as early as the mid-seventies, and had in many relevant fields been superceded by multipolar economic arguments no later than 1984.

## Conclusion

The foregoing timelines suggest three conclusions about mainstream support for basic science research over the past



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thirty years. First, the existence of a relatively stable consensus on the benefits of basic science research focused arguments on how to achieve those benefits rather than the potentially more divisive issues of what sorts of goals the science programs should address. Second, widespread acceptance of the value consensus, while useful, has perhaps overwhelmed interesting questions about the organization of basic science research. Ideologies respond to, move away from and incorporate arguments as often as they generate arguments. Third, arguments over science funding are not best explained in terms of a priori ideologies. We will discuss each item below and summarize the differences between and among ideological camps during the period studied.

The existence of a consensus--a constellation of values that includes health, environmental safety, economic competitiveness, security and national preeminence--makes easier the comparison of programs and the establishment of priorities. Though advocates from different political positions emphasize one or another element of the consensus at different times, their mutual resort to and respect for the counterarguments contributes to civilizing disagreements and focusing efforts at compromise.

It also has the potential for distracting attention from important differences. The stabilizing influence of the value consensus in tandem with relatively non-ideological patterns of argument, while serving to reduce the likelihood of deeply divisive, bitter contest over research, might also serve to deemphasize issues that could well bear additional scrutiny. The

value consensus is quite vague, and consistently so. Arguments over funding rarely describe the merits of policies in terms other than, on the one hand, broad assertions of national well-being and on the other very specific illustrations of how individuals can benefit from a given program. Questions about how benefits should be distributed, or even if benefits should be distributed beyond the action of the marketplace go largely unexplored. (Carter administration discussions of the social role of technology in domestic and foreign policy stand as a significant exception to this rule.) This phenomenon may indicate general satisfaction with the modes of social and political organization into which science must fit and it certainly parallels the broad agreement that science must not be held hostage to overtly political considerations.

It also, however, privileges certain modes of organizing science that comport with the reigning value consensus. For example, the argument that industry should carry out development and marketing and that government should decide project funding based in large part on the likelihood that a program may bring products to market--a hallmark of Reagan administration funding--uses the economic competitiveness rationale from the value consensus to bestow upon the private sector a critical role in the research process per se. Arguments that are quite healthy in other substantive areas (i.e., housing) about the propensity of business norms to promote even distribution of benefits go largely unheard in disputes over science funding. In other words, the stability of the value consensus can apparently serve to keep arguments out as well as to keep discussions focused.

The role of ideology, if understood as more or less coherent shared system of beliefs and values that condition the interpretation of data and the generation of agenda, is not often predictable. Still less is the influence of ideology easy to chart given the looser definition at work in this study. Democrats, Republicans, liberals, conservatives and to a lesser extent, doves and hawks, all recur to the same arguments at different times. On the other hand, once political boundaries are established, arguments seem often to be taken up by a group almost as a means of identification. For example, the transfer of governmentally supported research initiatives to the private sector for further development and marketing became, throughout the 1970s, an increasingly "Republican" argument. It had been used as early as the 1960s by Democrats and liberals as well, but became much more heavily identified with Republican politics through inclusion in Party documents and vigorous promotion by Party members, particularly members of the Reagan administration. Given the fluidity of ideology and argument in American politics, it would seem as important to identify the history of an argument vis a vis its supporters as it would to identify the nominal ideological orientation of the supporters before assessing the ideological character of a claim.

From 1960-1990, no differences consistently separated conservative from liberal, hawk from dove, or Democrat from Republican. There were, of course, centers of disagreement throughout the period. Conservatives and Republicans were less likely to argue vigorously in favor of enviromental research or

social sciences research. Democrats and liberals were less likely to make an articulate case for the role of private enterprise in the research community. Republicans and conservatives were less likely to favor the use of demonstration projects, Democrats and liberals moreso. Hawks were more likely to support centralized research, doves were consistently more interested in smaller, more dispersed projects.

It must be noted, however, that these disagreements were evident most often through omission. Those opposed to environmental research did not argue that such research is a bad thing, they argued instead about the soundness of particular programs. The goals were not directly at issue. Nor did any of the ideological groups tend to characterize their positions on funding for basic science research in terms of their ideological commitments. The same liberal who might have happily described a housing program as a "liberal" policy would not have been likely to case support for space research in explicitly "liberal" terms.

The influence of ideology on arguments over funding for basic science research seems to be most evident in tightly focused issue areas and in relatively short stretches of time. Further, it is likely to be found in the character of appeals rather than overt claims.

## Notes

1. We also ran Boolean searches through the DIALOG and NEXIS databases, but these did not prove to be particularly useful.

2. OTA supplied roughly 25% of the materials, consisting for the most part of presidential pronouncements and statements by the Presidents' Science Advisers.

3. The database consists of 265 documents. We sampled the opinions of 30 Democrats, 22 Republicans, 21 hawks, 29 doves, 56 liberals and 31 conservatives. An opinion leader could have been listed under as many as three headings. For example, Barry Goldwater, Sr., was a Republican, a conservative and a hawk. Likewise, an opinion could be listed in as many as three categories (hence the larger figure for opinions than for documents). 67 Democratic opinions were recorded, 53 Republican, 100 liberal, 64 conservative, 45 dove and 42 hawk.

4. J.W. Fulbright, "Is the Project Apollo Program to Land Astronauts on the Moon by 1970 a Sound National Objective?" Congressional Digest, vol. 44, No. 2, February 1965, pp. 47, 49, 51, 53.

5. Barry M. Goldwater, "Is the Project Apollo Program to Land Astronauts on the Moon by 1970 a Sound National Objective?" Congressional Digest, vol. 44, No. 2, February 1965, pp. 53, 55.

6. The Democrats phrased the space question in terms of competition and achievement. Republicans emphasized results. "[The United States] will continue to be the greatest reservoir of effective scientific knowledge in the world . . . Government must take a responsible role in science to assure that worthwhile endeavors of national significance are not retarded by practical limitations of private and local support." 1960 Republican Party Platform, reprinted in Bruce D. Johnson, National Party Platforms: Volume II, 1960-76 (Urbana: University of Illinois Press, 1978), p. 615.

7. Ibid., pp. 802-03.

8. Ibid., pp. 876-77.

9. Ibid., p. 934 and 984.

10. Office of Management and Budget, Issues '78 (Washington, DC: U.S. Government Printing Office, January 1977).

11. Frank Press, Director, Office of Science and Technology Policy, testimony before the House Committee on Science and Technology, Apr. 3, 1979.

12. Frank Press, "Science and Technology in the White House, 1977 to 1980: Part 1," Science, vol. 211, No. 4478, Jan. 9, 1981, p. 140.

13. Frank Press, "Science and Technology in the White House, 1977 to 1980: Part 2," Science, vol, 211, No. 4479, Jan. 16, 1981, p. 249.

14. George A. Keyworth, Director, Office of Science and Technology Policy, testimony before the House Committee on Science and Technology, Feb. 3, 1983. Keyworth's emphasis on the market emphatically might seem to contradict his position on demonstration projects. In testimony before the Committee on Science and Technology on Feb. 1, 1984, he said that the Administration made, in particular, "substantial reductions in energy-related demonstration projects." He called this "a reflection of both common sense and economic reality." His goal was to ready research for industrial development and to pursue research that seemed most promising in that regard, not to actually develop saleable products with government funds.

15. Irwin Goodwin, "Press Addresses a Political Dilemma, Choosing Among Scientific Priorities," Physcis Today, vol. 41, No. 6, June 1988.

16. "Loud and Clear: Science's New Voice at the White House Speaks Out," Scientific American, vol. 262, No. 1, January 1990.

17. 1988 Republican Party Platform, reprinted in The 1988 Congressional Quarterly Almanac (Washington, DC: Congressional Quarterly Press, 1989), p. 58-A.

18. Anne Gorsuch, Director, Environmental Protection Agency, testimony before the Subcommittee on Natural Resources, Agriculture Research and Environment of the House Committee on Science and Technology, Oct. 22, 1981.

19. Richard M. Nixon, "President's State of the Union Message," Weekly Compilation of Presidential Documents, vol 7, No. 3, Jan. 25, 1971.

20. Robert K. Oldham, "Patients as Research Partners: The Privatization of Cancer Research," Vital Speeches of the Day, vol. 53, No. 24, Oct. 1, 1987, pp. 763-66.

21. David Baltimore, "The Worsening Climate for Biological Research," Technology Review, vol. 92, No. 4, May/June 1989, p. 22.

22. Lewis Thomas, President Emeritus, Memorial Sloan-Kettering Cancer Center, New York, testimony before the Senate Committee on Agriculture, Nutrition and Forestry and the Subcommittee on Technology and the Law of the Committee on the Judiciary of the United States Senate, Nov. 4, 1987.

23. Fulbright, op. cit., p. 47; Goldwater, op. cit., p. 53.

24. "Should the Proposed Future U.S. Manned Space Flight Programs be Curtailed?" Congressional Digest, vol. 51, Nos. 6-7, June-July, 1972, pp. 176-91; Claude E. Barfield, "Space Report: NASA Gambles its Funds, Future on Reusable Space Shuttle Program," vol. 3, No. 11, Mar. 13, 1971.

25. Carl Sagan, Professor, Center for Radiophysics and Space Research, Cornell University, Testimony before the Subcommittee of Space Science and Applications of the House Committee on Science and Technology, July 30, 1975.

26. Frank Press, Director, Office of Science and Technology Policy, Testimony before the House Committee on Science and Technology, Jan. 26, 1978.

27. Phil Kuntz, "Space Firm Tries to Win Funds, Influence People," Congressional Quarterly Weekly Report, vol. 46, No. 15, Apr. 9, 1988, pp. 929-31.

28. Peter Clausen and Michael Brower, "The Confused Course of SDI," Technology Review, vol. 90, No. 7, October 1987, pp. 60-72; "SDI Boom--or Bust?," Scientific American, vol. 255, No. 5, November 1986, pp. 54B-54D.

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# Basic Research Goals: Perceptions of Key Political Figures

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# BASIC RESEARCH IN SCIENCE, 1960-90:
# PRIORITIES AND GOALS OF KEY FIGURES IN THE EXECUTIVE BRANCH

## INTRODUCTION

This report presents an analysis of selected public statements made to Congress about basic research since 1960. The statements were made by key political figures--Presidents, Cabinet Secretaries, and agency heads--as part of the budgetary process. The database for this analysis is described below in the discussion of methodology.

There are a number of different ways one might organize an analysis of the basic research goals of key political figures from 1960-90. One might, for example, chart the rise and fall of particular research programs, noting when and where they rose to become high priority, as well as when and where they came to be seen as less important. Though this might be useful for some purposes, there are three significant obstacles to this path. First, given the length and breadth of scientific concerns covered in the database, the expense in time and money of tracking each specific program would be prohibitive. Second, with surprisingly few exceptions, the testimony of political figures before Congress offers very little basis for assessing the relative priority placed by those figures on particular programs or areas of research. In fact, there are instances in which no specifics about the particular areas of research are provided at all.[1] Investigating why the database provides so few clues about the relative priority of particular programs and projects may be worthy of a separate study. One hypothesis is that officials arguing in support of their budget might be reluctant to hand Congress an easy guide

to where cuts can be made. The third shortcoming of this approach is that any gain in specificity would be accompanied by a loss in scope. That is, a focus on the details of the funding history of particular programs obscures the more general--and more enduring--patterns of justification with which the project is concerned.

In the project proposal "Basic Research for the 1990s," of which this report is but one part, this concern with broader patterns was highlighted: "Congress is raising new questions about the goals of basic research. Have these goals changed since the 1960s?" The proposal hypothesized that "links between economic competitiveness and the vitality of the basic research system have been claimed with increasing frequency in the 1980s. . . ." It was suggested that economic competitiveness had been added to more longstanding goals of basic research such as national military security, improved health and quality of life, and national pride. It seems appropriate, then, to test this hypothesis, and to focus on the broader goals and justifications for federal funding of basic research. The following report will focus on shifts in primary themes underlying statements of basic research goals. Of central concern will be the status of economic goals and justifications.[2]

## RESEARCH METHODOLOGY

### Database

This study is the result of a qualitative analysis of public arguments about basic research made by key political figures. The database analyzed was compiled by the Office of Technology Assessment. There are 133 texts, listed in the attached bibliography, totalling approximately 2085 pages.

The key political figures, with one exception (Rep. Fuqua), were selected on the basis of official roles, rather than on the basis of the characteristics or significance of the individual filling that office at a given time. This ensured continuity in the composition of the database over a long period of time. Those included are: six Presidents (Kennedy through Reagan); their Secretaries of Agriculture, Defense, and Energy; their Science Advisors; the Directors of the National Science Foundation and the National Institutes of Health; Administrators of the National Aeronautics and Space Administration; Presidents of the National Academy of Sciences and the American Association for the Advancement of Science; and the Honorable Don Fuqua, Chairman of the House Committee on Space, Science and Technology. The database consists of public statements made by these officials, almost exclusively in the form of testimony before or messages to Congress.

Not all texts were equally useful in the conduct of this analysis. The budget messages of the six presidents and the testimony of Directors of NSF and of Science Advisors were most useful because they covered a broad scope of scientific activity. Moreover, it was in these texts that discussions of the relative priority of different national purposes and problems were most frequently discovered. Testimony by Secretaries of Agriculture were less useful because they rarely discussed scientific research explicitly; as noted above, when they did, they often provided no specifics. Other elements of the database were available for only short segments of the period in question (Fuqua, AAAS) or were unrepresentative in that they were not presentations made to Congress (NAS);[3] for these reasons, they were given less consideration in the analysis.

Method of Analysis

Two aspects of the database placed certain limitations on the methods brought to bear on it: the absence of oppositional discourses and the sheer volume of text to be analyzed. The database was constructed, as noted above and for sound reasons, from the official testimony of various members of the Executive Branch before Congress. This provided continuity in the domains of interest represented across the span of the study, as well as affording an opportunity to gain a comprehensive picture of goals and priorities within a given administration. At the same time, this principle of selection reduced access to opposing views regarding the merits of specific projects, the goodness of fit of those projects with larger national goals, and the composition and relative importance of those national purposes. The report of a second research team (headed by Birdsell and Simons), which studied the influence of ideology on arguments for funding basic research, likely will provide insight into the nature of those opposing views. The primary impact on this study of that aspect of data selection is that points of contention--contested issues and warrants (justifications)--are less visible in the texts. In the give and take of argumentation, doubt about evidence, warrants, and ends are made explicit as disputants advance arguments in support of their position and question the arguments of opponents. Although it is still possible to identify some of these contested issues in the prepared statements of administration officials, there is a tendency for them to present arguments as unproblematic. Without the pressure of debate, it is less likely that officials will develop arguments; rather, they are more likely to make assertions, to present a series of "factual" statements that sublimate controversy. Thus,

a rigorous attention to subtle aspects of language and argumentative form, as well as to contextual meaning, would be the optimal approach to analyzing the texts.

Such an approach would pay careful heed to the significance of the particulars of a rhetorical situation: who is the speaker? who is the audience? what are the salient social, political, and psychological features of this particular situation? what specific exigences face both speaker and audience (e.g., budget deficits, off-year elections, unpopular [or popular] foreign policies)? In addition, special care would be paid to artistic features of the discourse (e.g., simile, metaphor, amplification), or to the use of particular techniques of argument (e.g., causal argument, method of residues). However, this type of rhetorical analysis, attentive as it is to close textual analysis and to the particulars of a given situation, is not feasible given constraints on time and the size and diversity of the database.

The following analysis, then, is based on the judgment of investigators trained in rhetorical analysis, sensitive to shifts in tone, to underlying premises and frameworks of justification, and to the importance of oft-times subtle linguistic strategies. Where it is useful in discerning relative priorities, attention has been paid to the use of metaphor in official discourses. Attention also has been paid to quantifiable aspects of the discourse, such as the frequency with which a goal is used to justify funding decisions; however, this is not a quantitative content analysis, and so this report does not tote up allusions to defense, competitiveness, and so on. Rather, these data are merely one factor in the formation of the necessarily subjective critical judgments presented herein. It is worth noting that even the most

scrupulous rhetorical analysis, developed with unlimited time and resources, is necessarily subjective; this ought not be taken to mean that this analysis is whimsical or idiosyncratic, but that it is an interpretive process.

## ANALYSIS OF THE DATABASE

A central thread running through the past thirty years of official discourse about federal support of basic research in science has been the link between such research and the economy. There is no period during which agency heads, Cabinet Secretaries, and Presidents have not cited the potential benefits of scientific research to the economic health of the United States and its citizens. What has changed, however, has been the amount of stress placed on economic impact, the goals to which that impact has been linked, and the language in which this factor has been formulated. In this report, we will trace shifts in these connections. These shifts will reveal an increasing emphasis on economic considerations and goals for basic research, as well as the ebb and flow of priorities such as space, pollution, and energy.

### The Early 1960s: Space, Progress, and Leadership

In the early 1960s, discussions of scientific research spoke of its beneficial effect on the economy: "progress." The centerpiece of this research was "the most dramatic effort of all--mastery of space symbolized by an attempt to send a man to the moon and back safely to earth."[4] The space program was justified as having "far broader significance . . . than the achievement of manned space flight. The research effort connected with the space program--and particularly the tremendous technological advances necessary to permit space flight--will have great impact on increasing the rate

of technical progress throughout the economy."[5] The source of the space program's impetus, the Soviet launch of Sputnik, suggests, however, a link to technological development and leadership--the prestige and security of the U.S.--that weighed more heavily than did any foreseeable economic gain. In 1963, the NASA Administrator said that the space program was

> undertaken in the face of a new Communist threat to our national security and to our position as leader of the free world. It was also undertaken on the assumption that the ability to operate in this new environment would produce scientific and economic benefits beyond our capacity to foresee. Five years ago the United States . . . [was] a second-rate power in space. Today, because we have carried out a sustained and driving effort, we have overcome the Soviet lead sufficiently to permit us to negotiate space matters from a position of strength.[6]

Themes of movement, advance, and progress are evident throughout the 1963 NASA testimony in references to the need "to move ahead" so that the U.S. does not "forfeit its leadership;"[7] in the request for funding that "will enable NASA to maintain our momentum, to sustain our ongoing program at an optimum pace;"[8] in a stress on "the importance of maintaining a sustained effort;"[9] and in a warning that "we must not proceed on a stop-and-go basis" which is "costly and inefficient."[10] These phrases resonate with metaphors not only of progress, but also of races and wars.

The prevalence of such metaphoric expressions links up with dominant conceptions of the era--the Space Race and the Arms Race--which participate in the overall theme of Cold War. These themes can be found elsewhere in the

database from this period. In 1963, President Kennedy framed his discussion of the budget in terms of meeting the needs of a "complex and growing society in an era of cold war."[11] War metaphors abound in statements by directors of NIH: "desire to accelerate man's age-old war against disease;"[12] "concerted attacks" and "systematic logical attack;"[13] "conquest of the conditions and diseases that harass mankind;"[14] "major assault on disease;"[15] "special task forces" on cancer;[16] and centers to "spearhead the attack on mental retardation."[17] All of this suggests that, although aiding the economy was cited as justification for research programs, it was a subsidiary goal. The prevalence of war metaphors suggests an interconnection of goals striving toward an ultimate purpose, leadership of the free world. For example, John F. Kennedy made a distinction between two kinds of budget deficits: "a chronic deficit of inertia due to inadequate economic growth" which would be "a sign of waste and weakness"; or "a temporary deficit," "an investment in the future . . . to assure more jobs . . . to achieve higher standards of living, and . . . to continue to provide the leadership required of us in the free world community."[18] As we will see, this perception of economic goals as instrumental in relation to those of progress and leadership changed in later years.[19]

## The Mid-1960s: Practical Applications to Immediate Problems

Beginning in the mid-1960s, emphasis was increasingly placed on research with clear and, preferably, immediate practical benefits. The shift is clearest, perhaps, in the testimony of directors of the National Science Foundation. In 1967, Leland J. Haworth said, "The assessment of the relative prior-

ity of various programs . . . must, in large part, depend on factors external to science and its basic intellectual challenges. The factors include rough assessments of the eventual utility of knowledge in relation to foreseeable needs of society."[20] He went on to note "that research priorities cannot be based on factors internal to science itself as has sometimes been assumed. External factors are paramount; the needs of society as established by the political community in public debate must be given great weight. . . ."[21]

Those priorities, in 1967, produced a stress on chemistry, social sciences, and ocean and atmospheric sciences. Key figures turned to the sciences, both natural and social, for the means to solve pressing problems of economy, crime, poverty, and pollution. "The contribution of chemistry tc all sectors of our economy is well known."[22] "The field of social sciences has been receiving special stimulus from the National Science Foundation. . . . Its purpose is not only to satisfy scientific curiosity . . . but to develop new knowledge . . . required along with engineering, biological, and physical science knowledge to devise solutions to such problems as urban development, explosive population growth, crime, and quality of environment."[23] "The justification for these major increases [in atmospheric and ocean sciences] is based on an estimate of the probability that the new basic understanding obtained through research in these fields will be applied quickly to society's present problems."[24] The NSF continued to stress these same three areas in upcoming years.[25] Increases were given to social science research in "economics, sociology and social psychology, the major part of the increased support being provided for research projects directly underlying or relevant to current social problems."[26] Moreover, a new program was announced, titled

"Interdisciplinary Research Relevant to Problems of Our Society," based on the belief "that scientists of different backgrounds can reexamine the problems of society . . . and provide useful insights and suggestions for innovative approaches leading ultimately to possible solutions."[27]

In 1971, Director William D. McElroy announced that NSF experience with "problem-focused research [in physical, life, and social sciences] has demonstrated to us the importance of using a special management approach in administering these types of societally relevant programs."[28] The new approach, Research Applied to National Needs (RANN), was designed "to develop more effective and efficient methods for coupling the knowledge and methodologies of science to efforts to resolve selected national, regional, and local problems, and to help advance national economic productivity."[29] This not only evidences a sustained trend toward practically-oriented research, but also gives an indication of the increasing emphasis being placed on economic constraints. In the same testimony, McElroy cited "the need to acquire scientific and technological knowledge that can provide a basis for the development of improved technology which can have a beneficial impact on the Nation's economic productivity" as a key consideration in setting priorities.[30]

The tension between a desire to fund research to resolve practical needs and the limitations funding of the Vietnam War placed on the economy was apparent in presidential budget messages at least as early as 1967. Lyndon B. Johnson noted that efforts "to defend the cause of freedom in Vietnam and to counter other threats to national security require substantial resources," but said those efforts could not be permitted "to sidetrack the struggle for individual growth and dignity at home."[31] As a result of concern for the

economy, he wrote: "We are not doing everything in space that we are technologically capable of doing. Rather, we are choosing those projects that give us the greatest return on investment."[32] Johnson acknowledged that "One of the most serious difficulties in solving city problems is our inadequate knowledge about the roots and nature of these problems," and urged more support for research in these areas.[33] Yet he added: "The problems of the city are many; the resources, limited."[34]

In 1968, Johnson remained focused on funding research aimed at solving practical, immediate problems: he identified as the "most urgent needs of our nation today--the basic problems of poverty, crime, and the quality of our environment."[35] And, even though he claimed we had "engaged in an unparalleled period of economic advance," he said that he had "had to set priorities . . . [and] choose among the competing demands on our resources."[36] Thus, cuts in NASA's budget were justified, in part, by the statement "To meet our most urgent national needs in some areas requires us to reduce spending in others."[37] Increases for research and development in transportation were justified by the claim that "our economic growth and well-being rely heavily on fast, efficient movement of goods and people."[38]

By 1970, Richard M. Nixon evidenced growing concern about the economy: "The 1971 budget shows a significantly different set of priorities. . . ."[39] His budget goals highlighted a continued emphasis on practical problems, including "a major effort to improve *environment quality*," but also proposed to "help restore *economic stability*."[40] The goal of restoration was indicative of a perception that the economy was in trouble. Thus, the new set of priorities resulted in cuts in defense and space research: he

announced "reductions in uneconomic programs . . . [with] the largest . . . taken in manned flight activities of the space program."[41] Space research and development would now "stress additional uses of space technology,"[42] and the NASA administrator explained that the emphasis of the manned space flight program was shifting to "earth orbit missions that produce direct and practical benefits for man."[43] The major areas receiving increases were pollution, transportation, housing, and crime reduction. The first, pollution, was the top priority, and here Nixon expressed a faith in science's ability to solve national problems similar to that which fostered increased support for the social sciences noted above: "Where technology has polluted, technology can purify."[44] Yet a later statement in the address foreshadows the precedence of energy and economic factors over environmental concerns that marked the mid- to late-1970s, as well as the shifting of responsibilities away from the Federal Government which marked the 1980s: "The major responsibility to reduce pollution rests appropriately with State and local governments and the private sector. However, the Federal Government must exert leadership and provide assistance. . . ."[45] The linkage of research on social problems and the economy is also shown by Pres. Nixon's 1971 statement that "The Office of Economic Opportunity will emphasize its leadership role in research, development, and evaluation in social programs."[46] Finally, the tone for funding scientific research through the rest of the decade was set in the address the following year: "New spending programs must be evaluated against the most stringent of standards: *do they have enough merit to warrant increases in taxes or elimination of existing programs*?"[47]

The seriousness of the energy crisis and its impact on other areas of research spending is, perhaps, most obvious in the first budget message from Gerald Ford. President Ford announced "a major new energy program [to] . . . promote energy research and development," to be accompanied by "a one-year moratorium on new federal spending programs other than energy programs."[56] The moratorium was justified as follows:

> The economy is now in a recession. . . . Underlying these problems is the fact that we are far from self-sufficiency in energy production, and even with the measures I have proposed, regaining the capacity for self-sufficiency will take years to achieve.[57]

In fact, the only discussion of research in the entire budget message is an elaboration of plans for increased energy research and development. Here he stressed continued "vigorous nuclear research" and acceleration of research into coal and solar energy. Also of note was the creation of ERDA, the Energy Research and Development Administration.[58]

The only references to the environment were to amendments to the Clean Air Act that would "allow greater use of domestic coal for electric power generation," and an indication that studies would be done to insure that new plans for leasing offshore oil and gas resources would "be accomplished safely and in an environmentally acceptable manner."[59] The environment seems to have been a concern, at best, only passively--in terms of avoiding damage to it by new plans for energy development. This assessment receives some confirmation from the fact that President Ford makes no reference at all to pollution or the environment in his 1976 and 1977 budget messages.

The 1975 testimony of the NASA Administrator provides further evidence of the salience of energy concerns and the economy in discussions of Federal research activity. "In energy research and development we are continuing our efforts of exploring ways in which aeronautical and space technology can be applied to meet the nation's energy problems."[60] Research and development expenditures were touted on the basis of their beneficial effect on the ailing economy: "Based on experiments and economic studies to date, we can foresee potential economic benefits to the U.S. of many hundreds of millions of dollars per year through uses of satellite collected data. . . ."[61] And, requesting funds for developing space technology: "The long-term answer to inflation is increased productivity; this too depends on advances in technology."[62] NASA continued this tack in 1977: "In energy technology applications, we are continuing to work closely with ERDA on studies of possible space-based energy delivery systems and on the conversion of space technology to terrestrial use."[63]

Signs of a shift towards stressing defense and basic research, although still with an emphasis on energy needs and economic problems, are found first in the 1977 Presidential Budget Message. President Ford wrote that he was "proposing real growth for basic research and development programs this year because [he was] convinced that we must maintain our world leadership in science and technology in order to increase our national productivity and attain the better life we want for our people and the rest of the world."[64] This increase included energy research and development; one-third of the overall increase was for defense.[65]

In his first budget message, Jimmy Carter said: "The spending priorities of the past are now being shifted toward long-neglected areas. . . ."[66]

> Included are increased emphasis on conservation and nonnuclear research and development. . . . [T]he national energy plan is essential to the future health and vigor of the American economy. The U.S. also must take the lead in minimizing the risks of nuclear weapons proliferation as we advance nuclear power and technology. Thus, this budget increases research and development funding for systems that present fewer risks than the plutonium-fueled liquid metal fast breeder reactor.[67]

The emphasis placed on energy by Nixon and Ford remained, but concern that nuclear energy technologies might bring with them military hazards is apparently new, and this seemed a move away from the fast breeder reactors that had been recommended before.

Carter's list of "long-neglected areas" also included defense, the environment, and basic research. He declared that his budget "also emphasizes [military] modernization and research and development to meet future challenges to our security."[68] In addition, "*The Federal Government has an obligation to nurture and protect our environment. . . .*"[69] Finally, "*The Federal Government must lead the way in investing in the Nation's technological future.*"[70] He noted that "investment in basic research . . . had fallen far too low over the past decade [so] . . . this budget proposes a real rate of growth of almost 5% for basic research in 1979. I believe this emphasis is important to the continued vitality of our economy."[71] Despite the avowals of shifts in priorities, President Carter's message seems largely to

be a continuation of trends begun under Ford. Recall that Ford's last budget message continued a call for a comprehensive energy plan, stressed the need to fund defense research and development, and announced a renewed growth in funding for basic research. The primary difference between the priorities expressed in the 1977 and 1978 budget messages seems to be the return of environmental concerns to the explicit priorities of the President.

By 1979, inflation, stemming in large part from energy needs, was the dominant concern of many key figures. Robert A. Frosch, NASA Administrator, testified, "Inflation continues as the country's most pressing problem, and the president's total budget, designed to reduce the deficit to less than $30 billion, is tight and austere."[72] Science Advisor Frank Press,too, said: "In order to help bring inflation to heel, it is essential that the government restrict its expenditures so as to minimize deficit spending. If we fail, our economy will be severely disrupted and the long-term well-being of our society will be harmed."[73] And Carter noted the tension between economic problems and national goals: "I have sought to reconcile the need for extraordinary restrictions on Government spending with the need to maintain a strong defense; to implement a national energy policy; to assist people in need; and to continue important public services and investments."[74]

Defense was first on Carter's list of priorities in a budget emphasizing "research and development to meet future challenges to our security."[75] Energy needs were next, with "special emphasis to developing advanced solar power technologies. The budget's proposals give increased attention to more efficient use of uranium, to nuclear proliferation and environmental problems, and to effective measures to deal with nuclear waste."[76] The renewed con-

cern with environmental matters is reflected as well in testimony by the Secretary of Energy: "Underlying all technology development and deployment activities, the Department budget reflects the high degree of concern that is being placed on the environmental aspects of these activities. It is clear that environmental concerns must be addressed effectively at each successive stage of technology development."[77] And two days later, in testimony by the Director of NSF: "We must continue to seek ways to solve environmental problems at a cost the Nation can afford."[78] President Carter announced "new and expanded programs" which included ones "to protect individuals and communities from pollution and other toxic substances;" all in all, far more attention to the environment than was given to it by President Ford in his addresses.[79]

Last, Carter reiterated a call for basic research couched in economic terms: "Finally, I believe that the Federal Government must lead the way in investing in the Nation's future. This budget, therefore, continues my policy of providing real growth in Federal support of basic research. . . ."[80] His science advisor echoed that call, casting the Federal Government as risk-taker, a characterization oft-repeated during the Reagan years: "When the risk is great or the cost inordinately high--but the potential profit to the Nation is large--government investment is often important and necessary."[81]

## The 1980s: Defense, Leadership, and Economic Competitiveness

Rising concern about our ability to compete economically and technologically, coupled with worries that the U.S. had become second to the USSR in military strength, dominated discussions of research priorities as the 1980s

began. In his final regular budget address, Carter had identified the most important areas of budgetary concern as "defense, energy, basic research, and the training and employment of our Nation's young people."[82] He claimed that "the long decline in real spending for defense that began in 1969 has been reversed."[83] Last, he cited fears that we might lose world leadership in technology, and again linked basic research to economic goals: "In the long run, economic growth depends critically on technological development. For many years, this country has led the world in producing new technology. We are in danger of losing this leadership. . . . The payoff . . . for basic research is long-term, but immense. We benefit today . . . from the investments in science made decades ago. We must continue such investments today to reap similar returns tomorrow."[84]

The election of Ronald Reagan was followed by an even greater stress on concerns about the economy and about national defense, the major area of federally-funded basic research in this period. President Reagan made no mention of basic research in his first budget message, but did lay out a new budget philosophy that established a set of value terms for future budgetary discussions. On one side were positive value terms of recovery, restoration, return, revitalization, and a move back to earlier ways; on the other were stagnation, the status quo, and destruction. For example, he spoke "about the economic crisis," about acting to "alleviate the grievous economic plight of our people;" his plan would "revitalize our economy," causing a "return to prosperity;" he had a "program for economic recovery" that "recognizes basic economic facts and, as humanely as possible, . . . will move America back toward economic sanity."[85] He predicted that this program would, "undoubted-

ly, face stiff opposition from those who are tied to maintaining the status quo. But today's status quo is nothing more than economic stagnation coupled with high inflation. Dramatic change is needed or the situation will simply get worse, resulting in even more suffering and misery, and possibly the destruction of traditional American values."[86] Clearly the stakes were high in his depiction; activity and change were essential, their absence potentially fatal.

These stakes are perhaps clearest in the testimony of the Secretary of Defense, who warned that there was "no time to temporize," that we had lost that "luxury" because the "reassuring abundance" of U.S. technological superiority to the Soviet Union was lost: "The margin for error is gone."[87] He characterized the situation in terms that allude to the economy and that introduce the value of competitiveness. What we need now for defense is "investment," because we are being "forced into . . . competition with the Soviets, and we are not maintaining a competitive posture."[88] The choices are as stark here as in Reagan's address: "We have permitted our naval capability to deteriorate, and now we have to restore it."[89] And Weinberger makes a clear link among national security, research and development, and the economy: "We must exploit two of America's greatest potential resources--our technological genius and our industrial prowess. Nowhere is the interdependence of economic vitality and our defense capability more evident than here."[90] Thus, the Department of Defense would "initiate critical research and development into new technology. . . ."[91]

The emphasis on value terms linked to restoration continues in Reagan's 1982 budget message, with talk of "recovery," "the return of . . . prosper-

ity," and the strengthening of the Nation's defenses to restore the margin of safety. . . ."[92] These terms also are found coupled with an emphasis on private sector activity. Reagan says changes in corporate taxation will provide a "growing stream of funds for modernization, new technology, new products, and new plants [that] will revive our lagging productivity, restore our competitiveness in world markets, and spur the steady growth of jobs, production, and real income."[93] There is still little said about research, save for the announcement of cuts in agricultural research and that "an unnecessary $2 billion in Government subsidies for new energy supplies and technologies has been cut."[94] But the consistent use of terms linked to metaphors of restoration, along with an emphasis on private sector activity, provides an ideological grounding and coherence to Administration positions in other testimony, advocating a move "back to the future" via basic research.

For example, the Science Advisor testified, "the Administration considers two areas--industrial rejuvenation and national defense--to be critically dependent on near-term advances in science and technology. Those priorities are evident in our economic policies and in our R&D budget proposals."[95] He concurred with the Defense Secretary, saying "we look to science and technology to provide us with technological superiority in defense."[96] Keyworth also defined "R&D as a means to achieve necessary national objectives. For that reason, . . . the Administration [is making] efforts to stimulate a strong economy and provide appropriate incentives for private sector expansion."[97] In 1983, Keyworth reinforced these priorities by explaining that the preference for growth in basic research in the physical sciences and engineering over that in the life sciences stemmed from a preference for "those

areas . . . which promise great return to our foremost national priorities--industrial advances to fuel our economy, and defense."[98]

The stress on restoration, and the linkage of defense, economy, and basic research is consistently found as well in the 1983 statements of President Reagan, Secretary Weinberger, and NSF Director Edward A. Knapp. Reagan made his research priorities clear: "My administration recognizes the Federal responsibility to maintain U.S. leadership in scientific research . . . a vital investment in the Nation's future. Such research lays the foundation for a strong defense . . . and for new technologies and industries that will help maintain our industrial competitiveness, create new jobs, and improve our quality of life." His administration, he said, had "been able to reinvigorate Federal support for basic scientific research."[99] If we look for specifics, though, he made no reference to research in sections of the speech on health, agriculture, transportation, or energy. What he did say about this last item, so essential throughout the 1970s, was that he had "significantly reoriented the country's approach to energy matters in the past two years. Reliance on market forces" was now being stressed.[100]

Secretary Weinberger stated: "We simply cannot wait to restore our military strength--we must do it now, this year, in this budget," adding that "we must make up for lost years of investment by undertaking the research and development, and force modernization . . . that are needed to meet threats that are likely to arise in the future."[101] Here again, the stakes are great and restoration through research and development investments are the key.

Director Knapp testified, "Special emphasis will be given to those areas with the greatest potential for improving the Nation's future economic health

and enhancing its technological capabilities. The funds will help restore and maintain the quality of science and mathematics education . . . and move us closer to the President's goal of maintaining the technological leadership of the United States today and into the future."[102] Knapp also described the Federal role in basic research as that of a risk-taker: "Because such investments are often large or very risky, and because their benefits are not easily capturable in the market, the private sector will tend to underinvest in such work."[103] This is in keeping with previously cited statements of the 1980s that frame issues of basic research in terms of a market economy (e.g., energy).

In the mid-1980s, Reagan and others in his administration declared the economy to be well on the road to recovery, and economic competitiveness and scientific and technological leadership increasingly became the primary values justifying research programs. "Vigorous, noninflationary economic recovery is well under way."[104] The president's science advisor reiterated links to the economy when he testified that "strong support for basic research permits U.S. scientists to challenge intellectual frontiers in the most important fields of science and technology. That provides the new knowledge that drives our economic growth, improves our quality of life, and underlies our national defense."[105]

The space program appeared on the agenda, linked to leadership, competitiveness, and the private sector: "We can look forward confidently to the next major challenge in space--a space station . . . intended to enhance the Nation's science application programs, to help develop advanced technologies potentially useful to the economy, and to encourage greater commercial use of

space."[106] Biomedical research also returned to a featured place in testimony before Congressional committees. "Recent government and private industry studies attest to the NIH role in fostering the Nation's leadership in biotechnologies."[107] Rather than the assault on cancer of the early 1970s and similar past projects, the focus was now on activities of the NIH with impact on U.S. leadership, economic competitiveness, and partnership between public and private sectors: "I am happy to report to you that because this property was available, the NIH has been able to launch an important new program whose funding comes not from the government but from the private sector."[108] The Director of NSF also made mention of biotechnologies in his 1985 testimony: "This budget request . . . [i]ncreases support for research related to U.S. economic competitiveness such as Engineering research centers and Biotechnology."[109]

It was Erich Bloch, NSF Director, who made the most explicit statements about the justification of funding for basic research in terms of desire for leadership and the goal of economic competitiveness. In 1985 he cited as a key reason for the increasing dependency of U.S. industry on basic research the desire "to stay ahead of international competition."[110] In 1987, Bloch was even more explicit: "It is high time that economic competitiveness moves to center stage."[111] He explained: "if we want to compete successfully as a nation, the most important thing is to stay ahead of our competitors in continually generating new ideas, through basic research, and turning them into high quality, innovative products and services for the market place."[112] Bloch also stated that "the National Science Foundation plays an increasingly critical role in the national quest for economic competitiveness . . . by pro-

viding linkages among the vital elements of the scientific and engineering enterprise. . . ."[113] Bloch makes clear that economic competitiveness had become the primary justification for Federal basic research activity.

## CONCLUSION

This report has argued that the economy was consistently present among justifications for Federal funding of basic scientific research during the period covered by this study. What changed during this period was the relative importance attached to economic considerations and the constellation of other values with which the economy was arrayed.

At the start of the 1960s, testimony by key political figures suggests that the economy was only one among many considerations, and that it was subordinate to goals of progress and leadership. As the domestic economy worsened, not surprisingly, the economy became increasingly significant. At first this took the form of a stress on resolution of urgent social problems, with belt-tightening required by the Vietnam War and growing inflation pushing towards a priority for research that promised more immediate benefits for urgent problems, including pollution, a serious concern in the late-1960s and early-1970s. The growing energy crisis led to a deemphasis of environmental concerns and a growing prominence of the economy as a priority in setting research goals in the mid-1970s. The late-1970s saw deepening economic and energy problems, although environmental concerns reemerged as an explicit item on the agenda. In the early 1980s, the metaphor of restoration dominated the testimony of key political figures, providing a stress on defense and the economy, as well as lending the testimony of various Administration officials a

thematic and ideological coherence that earlier administrations had lacked. In the mid- and late-1980s, "economic competitiveness" became the dominant term in official discourse, clearly preeminent among all justifications for basic research in the sciences.

APPENDIX A: TIMELINE SUMMARIES

Below are summaries of major trends apparent from review of the testimony of heads of various cabinet departments and federal agencies represented in the database. The budget addresses of the six Presidents are amply represented in the analysis above, as is the testimony of the Directors of the National Science Foundation and that of the National Science Advisors, so these are not summarized.

AGRICULTURE

Through much of the 1960s, the focus of the statements by Agriculture Secretaries was revitalization of rural areas, and there was little specific discussion of research. Environmental concerns dominated discussions of research in agriculture from 1969 through 1973, with particular concern expressed for finding alternatives to the use of chemicals as pesticides and in fighting plant and animal disease. In 1971, for example, the Secretary spoke of pursuing the goal of "modification in the use of agricultural chemicals. For example, we are already beginning to use a number of biological control mechanisms to replace the more toxic chemicals."[114] There was a recurrent concern with research in human nutrition through the late 1960s and 1970s, as well as with finding means for improving the productivity of American farms.[115] The hearings examined from the 1980s make no reference to specific research activities receiving priority.

DEFENSE

It can be little surprise that one recurrent justification for defense research and development throughout the period studied, 1961 through 1987, has been the need to keep pace with (or stay ahead of) the Soviet Union in the development of new military technologies and in the capability to employ existing ones.[116] This justification is tied recurrently to the goal of deterrence, which requires that the U.S. maintain a credible second-strike threat; in the 1981 and 1985 hearings, the goal of ensuring and maintaining a war-fighting capability is cited as well, but with no explicit discussion of the implications of that goal for defense priorities nor of its compatibility with the goal of deterrence. Concern with the Soviet Union is least prominent in the goals and justifications for defense research and development as stated in Congressional hearings during the period from 1963 through 1973, perhaps reflecting the concern with U.S. involvement in Vietnam (Project AGILE, work on infrared technology, and the 1971 goal of making fighting men more mobile and less vulnerable[117] seem to support this interpretation). Beginning with the 1975 hearings, growing concern is expressed about matching a Soviet push in defense research and development, particularly in nuclear capabilities. "In our prices, the Soviets now devote more resources than the United States in most of the significant categories of defense. In overall Research and Development, they outstrip us by 20%. . . ."[118] This concern moves center stage in the four hearings from the Reagan years; in 1981, the possibility of the U.S. becoming second in nuclear and nonnuclear military power is raised and, in 1983, a call is made for modernization of conventional and nuclear forces in the face of a real threat from the U.S.S.R.[119]

(This trend is also apparent in the statements of national science advisors from 1980 through 1984.) The development of missiles, warning systems, and other elements needed for an ABM system received high priority throughout the 1960s (e.g., Nike-Zeus, Project DEFENDER), as did research on V/STOL aircraft (until budgetary considerations seemed to lead to a decision in 1969 to buy British V/STOL aircraft, Harriers).[120] Space-related defense activities were prominent through the hearings in the 1960s,[121] returning briefly in 1977[122] and becoming very prominent in the 1987 hearings (SDI).[123] Defense research is also linked to the expansion of knowledge and the improvement of the technological base of the U.S. in a number of hearings (1963-65, 1971-73, and 1985).

ENERGY

Concern with securing sufficient energy supplies first emerges in the 1973 Presidential Budget Address.[124] The top priority was finding ways of making the U.S. less dependent on foreign countries for its meeting its energy needs in the wake of the formation of OPEC. At the same time, rising concern with environmental issues such as water and air pollution spurred research on developing cleaner, more efficient energy sources. "Underlying all technology development and deployment activities, the Department's budget reflects the high degree of concern that is being placed on environmental aspects of these activities."[125] Nuclear power was an avenue frequently stressed, though the accident at Three Mile Island in 1979 seemed to slow work on fast-breeder reactors. The Carter Administration placed particular emphasis on achieving short-term results in meeting national energy needs through work on cleaner

burning coal, solar electrical power, etc.; though economic goals were cited, environmental safety received great emphasis. The 1980s saw a marked shift in the priorities of the Department of Energy, emphasizing long-term rather than short-term research and stressing the role of the federal government as a risk-taker, pursuing risky research and development projects that, if potentially profitable, are to be turned over to the private sector for commercial development. "briefly stated, this new strategy will require the government to focus its support on longer term, high risk research and development which industry cannot reasonably be expected to undertake."[126] Alternative energy research decreased in the 1980s as the Secretary announced: "A major environmental initiative which will receive increased emphasis is our effort to find ways to burn coal more cleanly";[127] basic research in high energy and nuclear physics increased.[128] Acid rain and SDI appeared on the agenda late in the 1980s. Little reference was made about environmental concerns until the 1987 hearings, at which both acid rain and the "greenhouse effect" received mention. A concern with the competitiveness of American science and technology became a key goal under Reagan, reflected by the Secretary's claim of a "strong commitment to . . . a major Administration initiative to maintain and strengthen the Nation's scientific leadership and technological competitiveness."[129]

NASA

Not unexpectedly, the primary focus of NASA from 1961 through 1969 was achieving President Kennedy's announced goal of landing men safely on the moon by the end of the decade. In 1963, NASA Administrator James E. Webb said: "The

total figure for the decade [$35 billion], I should note, includes the $20 billion estimated for manned space flight, and accomplishment of the national goal of using a team of American astronauts to explore the moon within the decade."[130] The use of satellites for communications, meteorological observation and research, and earth resources surveys has been a persistent emphasis of the agency.[131] The investment in space has been justified on the basis of its significance to perceptions of U.S. leadership in science, technology, and world affairs, and of expanding knowledge of the universe. For example, in 1983 the Administrator argued, "The Advanced Communications Technology Satellite (ACTS) Projects . . . calls for development and flight testing of the high-risk technology needed to ensure continued U.S. preeminence in the field of satellite communication."[132] As the lunar landing neared and the economy tightened, the practical benefits of the use of space and of space-related technology received increasing emphasis.[133] The end of Apollo produced a need for a new priority to guide the agency's activities, and to justify continued high levels of funding. In the mid-1970s, the Space Shuttle began to move to center stage, becoming the top priority in space under the Reagan Administrations. Carter's NASA Administrator announced: "The next generation of space transportation, eclipsing the expensive expendable launch vehicles in present use, will be NASA's reusable space shuttle. . . . The shuttle is a visible symbol of American capability. Already it is a major element of foreign policy, offering the U.S. the options of selective competition or cooperation in space research and operations."[134] The loss of Challenger seemed to mark a move toward more diversified priorities, but the Administrator reiterated support for manned space projects, especially a space

station.[135] Another significant shift in the 1980s was an increasing emphasis on commercial uses of space, as well as on the use of space for defense (SDI). The 1987 budget, for example, features a heading entitled Commercial Programs, and the Administrator announced the Civil Space Technology Initiative (CSTI), "an important first step in sustaining United States industrial competitiveness and leadership in space."[136] In aeronautics, the development of a civilian supersonic transport was a high priority during the 1970s not only in the statements of NASA directors, but also in Presidential budget messages. As in many agencies, pollution and energy-related concerns were given some emphasis during the 1970s, with declining interest and importance during the 1980s.

NIH

Mental retardation was a high priority in the early 1960s, but virtually disappeared soon after the death of Kennedy, who had emphasized it.[137] Certain chronic diseases, such as cancer and heart disease, remained relatively constant as important areas of research. Virology received great emphasis until the mid-1970s, at which time genetic research moved to center stage. The discovery of recombinant DNA and subsequent investigations into its implications apparently altered the focus of research stressed by directors of NIH. "Research on recombinant DNA therefore holds promise of becoming a powerful tool in the conquest of disease and, ultimately, in the prevention or correction of inherited malfunctions or disabilities."[138] An increased emphasis on biotechnology is clear in the statements of NSF directors under Reagan, stressing not only its medical benefits but also its economic and agricultural con-

tributions to the country.[139] The effects of pollutants on human health were a topic of some concern, first expressed in 1965, but never reached the level of priority of virology and genetic research. AIDS first appears in the 1983 NIH testimony; it also receives mention in the 1986 Presidential Budget Message and the 1987 testimony of the national science advisor. The goals and justifications for research in health are fairly consistent--improving the health of the American people, curing particular chronic diseases, and contributing to the economic health of the nation by producing a healthier workforce.[140]